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SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING

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and
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BIOMEDICAL LABORATORY
AEROSPACE MEDICAL LABORATORY

SEPTEMBER 1961

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AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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SEPTEMBER 1961

PROJECT No. 7164
TASK No. 71833

AERONAUTICAL SYSTEMS DIVISION
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FOREWORD

Liquid and semisolid foods in tubes have been developed for the Aerospace Medical Laboratory, Aeronautical Systems Division, by the Quartermaster Food and Container Institute for the Armed Forces. The work was administered by the Physiology Branch, Biomedical Laboratory, Aerospace Medical Laboratory in support of Project No. 7164, "Space Biology Research," Task No. 71833, "Nutrition in Aerospace Flight." These tubed foods were evaluated for suitability for in-flight feeding by the Physiology Branch from November 1958 through May 1959.

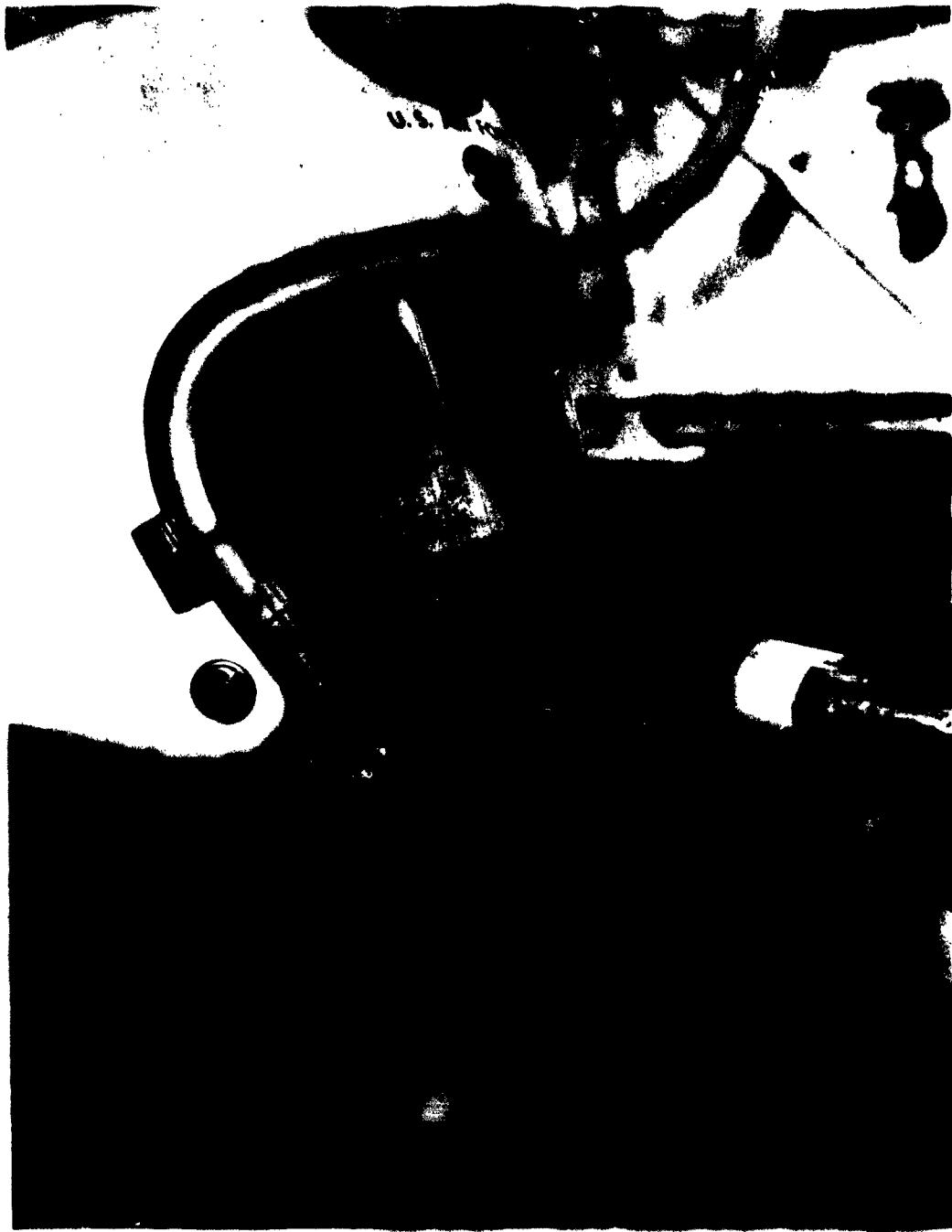
The assistance and cooperation of the following are gratefully acknowledged: Major D. F. Moe, USAF, VC, for his help in establishing the testing program; Major T. H. Mowry, USAF, for arranging for the students of the Physiological Training Unit to participate as subjects; and the Statistical Section of the Aeronautical Research Laboratory for their help and guidance with the statistical portion of this report.

ABSTRACT

Nineteen tubed foods were evaluated to determine their acceptability and suitability for in-flight feeding under restricted flight conditions. Ten of the foods were evaluated both at ground level and at a simulated altitude of 30,000 feet with the subjects wearing the MA-2 pressure helmet. The remaining nine foods were evaluated at ground level without a helmet. Results indicate that tubed foods are a practicable and acceptable method of feeding aircrews under the above conditions. Twelve of the nineteen foods in the tubes had a sufficient degree of acceptability to warrant their use in operational situations.

PUBLICATION REVIEW

Jos M Quashnock
JOS. M. QUASHNOCK
Colonel, USAF, MC
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Subject Eating Tubed Food While Wearing MA-2 Oxygen Helmet



Subject Eating Tubed Food While Wearing MA-2 Oxygen Helmet

SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING

INTRODUCTION

Present and future Air Force missions in high-performance aircraft or space vehicles require personnel to perform under restricted conditions (e.g., pressure suits, weightlessness). Normal feeding methods may sometimes be difficult. As a part of the program to provide Air Force personnel with the best possible nutrition in all situations, tubed foods were developed to meet these flight restrictions.

Foods, necessarily of liquid and semisolid consistency, are contained in pliable aluminum tubes. These tubes are fitted with screw-on, 5-inch plastic tubes (pontubes) through which the foods are squeezed by hand (see illustration, opposite). The tubed foods are heat sterilized, vacuum packed, and stable at room temperatures for several months.

The advantages of the tubed foods which were tested are:

- a. Personnel do not need to remove the pressure helmet to eat the foods.
- b. The foods do not require refrigeration for storage.
- c. They are ready to eat.
- d. They are not affected by high altitude.
- e. They require little storage space and even less disposal space.

METHOD AND RESULTS

General

Nineteen tubed foods were evaluated in two different experiments designed to determine their palatability and suitability for in-flight feeding under restricted flight conditions. One group of subjects evaluated 10 of the tubed foods (Experiment 1), while a second group evaluated the other 9 foods (Experiment 2). The foods were warmed or cooled as appropriate for palatability.

Subjects were instructed to eat enough of the food to make a positive rating, but were not required to eat the complete contents of the tube (all subjects did consume at least 50 percent of each tubed food they tested). The hedonic (9-point like-dislike) scale (figure 1) was used to determine the degree of acceptability of foods (ref. 2).

FOOD PREFERENCE QUESTIONNAIRE (HEDONIC SCALE)

| | | |
|-------|---------------------------|-------------------------------|
| Name: | Age: | Sex: |
| Date: | Are You on Flying Status: | Are You Military or Civilian: |

This is a questionnaire to obtain information about certain food items which you consumed. Rate the items consumed on the scale below by circling the number under the words that most nearly describe how much you like or dislike the item.

| Item | Number of Units Taken | Amount Consumed in Units or Fractions of Units | Like Extremely | Like Very Much | Like Moderately | Like Slightly | Neither Like nor Dislike | Dislike Slightly | Dislike Moderately | Dislike Very Much | Dislike Extremely |
|------|-----------------------|--|----------------|----------------|-----------------|---------------|--------------------------|------------------|--------------------|-------------------|-------------------|
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 8 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

If you so desire, please make additional comments about the foods you have consumed.

Figure 1. Nine-Point Hedonic Scale

Experiment 1

Procedure:

Twenty-five subjects (average age 28), wearing the MA-2 oxygen helmet, tested 10 tubed foods at ground level and at a simulated altitude of 30,000 feet. The 10 foods were divided into two similar groups of about equal preference as determined by preliminary testing:

Group 1

Semisolid Chicken (warm)
 Liquid Beef (warm)
 Semisolid Ham (warm)
 Applesauce (cold)
 Milk-Coffee (warm)

Group 2

Liquid Chicken (warm)
 Semisolid Beef (warm)
 Sweet-Sour Pork (warm)
 Chocolate (warm)
 Vegetable Juice (cold)

Each subject tested 5 tubed foods at ground level and, 3 days later, at a simulated altitude of 30,000 feet. This was repeated after another 3 days with the other 5 foods. All tests were conducted between 1100 and 1200 hours with the subjects instructed not to eat prior to the tests. The foods were eaten in random order. The tubes were labeled so the subjects knew what they were eating.

Results:

The mean hedonic scale ratings of 6 of the 10 tubed foods indicate sufficient acceptability to warrant consideration for operational use:

| <u>Tubed Food</u> | <u>Mean Hedonic Scale Rating</u> |
|-------------------|----------------------------------|
| Applesauce | 8.3 |
| Vegetable Juice | 7.4 |
| Semisolid Beef | 7.3 |
| Chocolate | 7.1 |
| Semisolid Chicken | 6.9 |
| Semisolid Ham | 6.7 |

The mean hedonic scale ratings of the remaining four tubed foods, 4.6 or below, indicate that these foods are of doubtful value for further use.

The range of acceptability (mean rating) for a 95 percent confidence limit (ref. 5) and percent dislike are given in table I. Mean ratings were also computed for the ground and altitude chamber tests, but the differences in ratings were not statistically significant as determined by the T test.

None of the subjects had any difficulty in consuming the tubed foods. However, they had occasional difficulty in opening the tubes. This problem was corrected before Experiment 2 by enlarging the pontube caps.

The subjects consuming the tubed foods at a simulated altitude of 30,000 feet while wearing the MA-2 oxygen helmet reported "...is method of feeding would probably be suitable for use in high-performance aircraft and space vehicles.

TABLE I
FOOD PREFERENCE - EXPERIMENT 1

| | CHAMBER TESTS | | | GROUND TESTS | | | 95% Confidence Limits |
|-------------------|---|--------------------|-----------------|--------------|--------------------|-----------------|-----------------------|
| | Mean Rating with Standard Error of Mean | Standard Deviation | Percent Dislike | Mean Rating | Standard Deviation | Percent Dislike | |
| Applesauce | 8.3 ± .05 | 0.22 | 0 | 8.5 ± .04 | 0.21 | 0 | 8.2 - 8.4 |
| Vegetable Juice | 7.4 ± .36 | 1.76 | 12 | 7.2 ± .31 | 1.51 | 12 | 6.7 - 8.2 |
| Semisolid Beef | 7.3 ± .22 | 1.06 | 0 | 7.2 ± .08 | 0.28 | 0 | 6.8 - 7.7 |
| Chocolate | 7.1 ± .30 | 1.48 | 4 | 6.5 ± .21 | 1.04 | 0 | 6.5 - 7.7 |
| Semisolid Chicken | 6.9 ± .21 | 1.01 | 4 | 6.7 ± .25 | 1.20 | 8 | 6.5 - 7.3 |
| Semisolid Ham | 6.7 ± .19 | 0.94 | 0 | 6.4 ± .26 | 1.29 | 8 | 6.3 - 7.1 |
| Sweet-Sour Pork | 4.6 ± .34 | 1.66 | 52 | 4.0 ± .38 | 1.94 | 56 | 3.9 - 5.2 |
| Milk-Coffee | 4.6 ± .48 | 2.35 | 60 | 4.6 ± .55 | 2.57 | 52 | 3.6 - 5.5 |
| Liquid Chicken | 4.5 ± .47 | 2.31 | 48 | 3.9 ± .37 | 1.97 | 60 | 3.5 - 5.4 |
| Liquid Beef | 3.8 ± .43 | 2.13 | 56 | 3.5 ± .33 | 1.64 | 52 | 2.9 - 4.6 |

Experiment 2

Procedure:

Fifty subjects tested 9 tubed foods at ground level. Each subject (average age 31) rated 3, 4, or 5 foods depending upon whether he was in a 1- or 2-day session. A variety of food types (dinners, soups, and fruit) was fed at one time. A total of 485 ratings was received. Each tubed food had at least 50 ratings. All tests were conducted between 1100 and 1200 hours and, in contrast to the previous experiment, the tubed foods were identified only by numbers.

The nine foods tested were:

Beef Dinner (warm)
 Fruit Dessert (cold)
 Vegetable Meat Soup (warm)
 Chicken Dinner (warm)
 Pork Dinner (warm)

Beef Noodle Soup (warm)
 Veal Dinner (warm)
 Chicken Noodle Soup (warm)
 Peaches (cold)

TABLE II
 FOOD PREFERENCE - EXPERIMENT 2
 MEAN RATINGS ON HEDONIC SCALE - 50 SUBJECTS

| | Mean Rating with Standard Error of Mean | Standard Deviation | Percent Dislike | Percent Consumed (Mean) | 95% Confidence Limits |
|---------------------|---|-----------------------|--------------------|-------------------------------|-----------------------------|
| Peaches | 7.7 ± .17 | 1.24 | 4 | 86 | 7.36 - 8.04 |
| Fruit Dessert | 7.3 ± .17 | 1.27 | 2 | 71 | 6.96 - 7.64 |
| Pork Dinner | 6.7 ± .21 | 1.45 | 10 | 74 | 6.28 - 7.12 |
| Veal Dinner | 6.2 ± .22 | 1.67 | 18 | 66 | 5.76 - 6.64 |
| Beef Dinner | 6.1 ± .22 | 1.60 | 20 | 67 | 5.66 - 6.54 |
| Beef Noodle Soup | 5.9 ± .25 | 1.75 | 24 | 69 | 5.40 - 6.40 |
| Vegetable Meat Soup | 5.2 ± .27 | 1.96 | 37 | 54 | 4.66 - 5.74 |
| Chicken Dinner | 5.0 ± .32 | 2.23 | 41 | 52 | 4.36 - 5.64 |
| Chicken Noodle Soup | 4.4 ± .25 | 1.88 | 56 | 51 | 3.90 - 4.90 |

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Results:

The mean hedonic scale ratings (see table II) of 6 of the 9 tubed foods indicate sufficient acceptability to warrant consideration for operational use:

| <u>Tubed Food</u> | <u>Mean Hedonic Scale Rating</u> |
|-------------------|----------------------------------|
| Peaches | 7.7 |
| Fruit Dessert | 7.3 |
| Pork Dinner | 6.7 |
| Veal Dinner | 6.2 |
| Beef Dinner | 6.1 |
| Beef Noodle Soup | 5.9 |

The mean hedonic scale ratings of the remaining three tubed foods indicate that these foods are of doubtful value for further use.

The range of acceptability (mean rating) for a 95 percent confidence limit (ref. 5) and percent dislike are given in table II. No statistically significant differences were found in the results which could be related to differences between ages of the subjects or between students of the 1- and 2-day sessions.

DISCUSSION AND CONCLUSIONS

These limited experiments indicate:

- a. Tube feeding is a suitable method where flying suit pressurization must be maintained or body movement is restricted as in high-performance aircraft or space vehicles.
- b. A sufficient number of acceptable tubed foods is available for operational use.

The comments of the subjects and the observations of the monitors indicate:

- a. Foods processed and packaged in tubes and eaten for a short period of time do not produce gastrointestinal upsets or other disorders.
- b. Subjects tend to dislike liquid meats.
- c. More variety of foods is needed.
- d. Further studies on the effects of food monotony are needed (ref. 3).

Twelve of the nineteen tubed foods had a sufficient degree of acceptability to warrant consideration for operational use. The tubes were easily handled after the pontube caps were enlarged. The subjects had no difficulty in learning how to use them or in consuming the foods.

Tubed foods were used successfully in a balloon flight (ref. 1). Experiments are now in progress to study swallowing and suitability of tube feeding during short periods of weightlessness (ref. 4).

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| 4 | ASD TR 61-456 | Aeronautical Systems Division, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING, by J. L. Welbourn and P. A. Lachance, September 1961, 12 p. incl. illus., tables, 5 refs. (Proj. 7164, Task 71833) Unclassified report | UNCLASSIFIED | ASD TR 61-456 | Aeronautical Systems Division, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING, by J. L. Welbourn and P. A. Lachance, September 1961, 12 p. incl. illus., tables, 5 refs. (Proj. 7164, Task 71833) Unclassified report | UNCLASSIFIED |
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| 4 | ASD TR 61-456 | Aeronautical Systems Division, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING , by J. L. Welbourn and P. A. Lachance, September 1961, 12 p. incl. illus., tables, 5 refs. (Proj. 7164; Task 71833) Unclassified report | Aeronautical Systems Division, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio SUITABILITY OF TUBED FOODS FOR IN-FLIGHT FEEDING , by J. L. Welbourn and P. A. Lachance, September 1961, 12 p. incl. illus., tables, 5 refs. (Proj. 7164; Task 71833) Unclassified report | |
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